

# A System Coupled to Gammasphere for Studying Short-Lived Electron-Capture-Delayed Fission Activities

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Electron-capture-delayed fission (ECDF) is a decay mode in which electron capture (EC) leads to large excitation energies in the decay daughter which then fissions. Neutron-deficient odd-odd actinides have Q-values for EC comparable to the height of the fission barrier and thus are expected to decay via ECDF. It is also possible that the excited daughter can decay by photon emission, leading to structural information about the normal deformed and superdeformed potential wells. This double-well structure results when shells effects are applied to the liquid drop potential. The aim of this study is to elucidate the superdeformed structure of <sup>232</sup>Pu populated from <sup>232</sup>Am EC while simultaneously observing the ECDF process.

In a preliminary experiment in September 2001, <sup>232</sup>Am ( $t_{1/2} = 1.31 \pm 0.04$  min) was produced in the <sup>237</sup>Np(<sup>3</sup>He<sup>2+</sup>, 8n) reaction at the LBNL 88-Inch Cyclotron. The Cave 0 multiple actinide target system (LIM2 [4-5]) was used and the energy of the beam entering the first target was approximately 75 MeV. A stack of 10 thin <sup>237</sup>Np targets (124-197  $\mu\text{g}/\text{cm}^2$  each) was used to maximize yield. Recoiling products were collected on KCl aerosols and transported by a helium flow to a "Sample Changer" [6] mounted inside Gammasphere in Cave 4C.

The Sample Changer is an automated system specially designed to collect samples and transport them into Gammasphere. It consists of four stations: foil loading, sample collection, detection, and foil disposal. Polypropylene foils (70-80  $\mu\text{g}/\text{cm}^2$ ) at the foil loading station are moved into the sample collection station where the KCl aerosols are deposited on successive foils. The activity-laden foil is then moved into Gammasphere for analysis.

The September 2001 experiment revealed a number of flaws in the design of the Sample Changer that needed to be fixed. A new computer-based motion control system and higher performance motor were purchased and a new Windows-based control program was developed. The sample holders were re-

machined to prevent jamming and the air-powered piston that moved the samples into Gammasphere was slowed for improved performance.

In December 2001 a second experiment was conducted using the same reaction as the September 2001 experiment. This time the Gammasphere/Sample Changer combination performed almost flawlessly. During almost 80 hours of operation approximately 1590 samples were collected and analyzed. One failure resulted in less than two hours of downtime. Two LEPS x-ray detectors and two silicon particle detectors augmented Gammasphere's normal array. The silicon detectors recorded over 700 fission events and many more alpha events while the LEPS detectors recorded plutonium x-rays resulting from americium EC decay. The data are still being analyzed but preliminary analysis has shown both plutonium x-rays and gamma rays in prompt coincidence with fission. These data should lead to information concerning the structure of rotational bands in the normal deformed and superdeformed wells of <sup>232</sup>Pu and the ECDF properties of <sup>232</sup>Am. This experiment shows the promise of using Gammasphere to study actinide nuclides which would otherwise be unavailable due to the need for highly radioactive targets or nuclides that can only be effectively studied after pre-separation, e.g., using the Berkeley Gas-Filled Separator.

## Footnotes and References

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